10-8-2019

Networked Microgrids and Transactive Controls

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November 14, 2019

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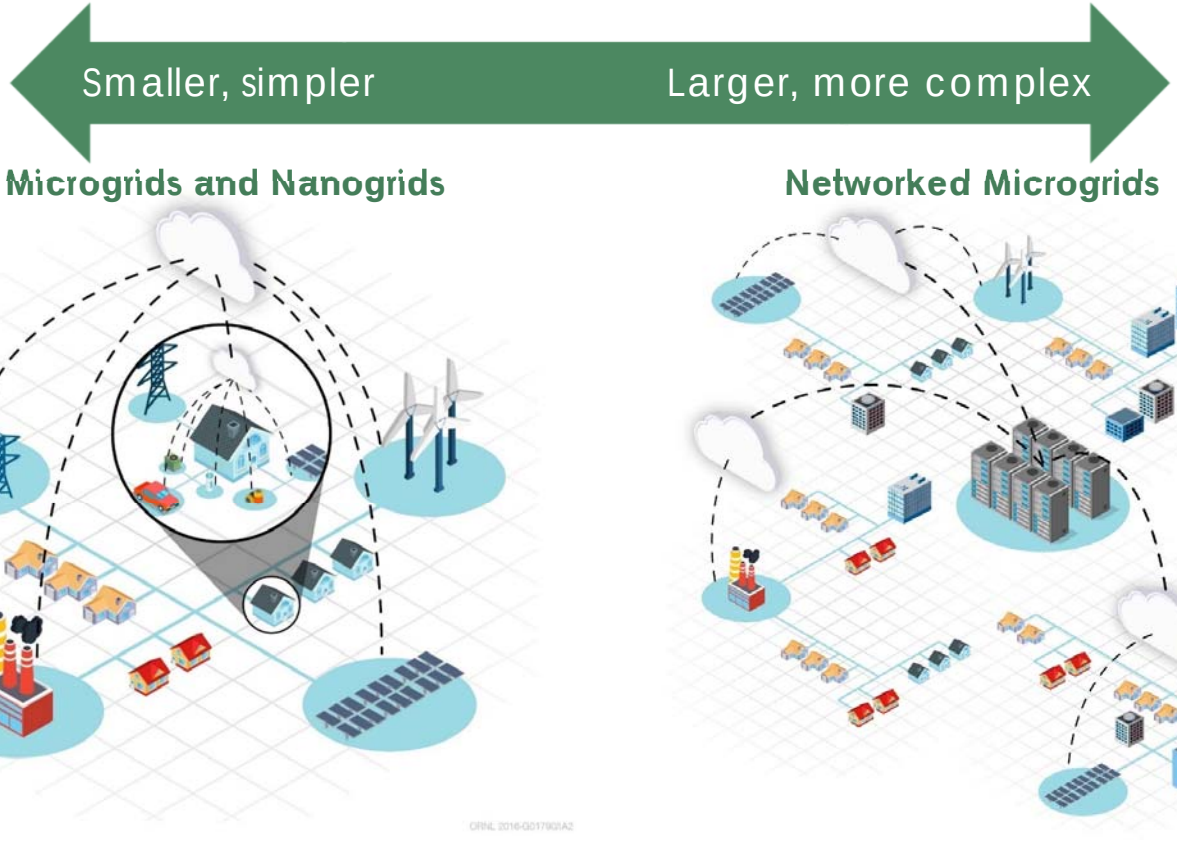
U.S. DEPARTMENT OF ENERGY

What is a Microgrid?

A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.



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Why Study Microgrids?

Hardened microgrids can help boost resiliency in areas affected by disasters

During blue-sky, microgrids can enhance electric system controllability and provide grid services

- Renewable integration
- System peak reduction
- Ancillary services near load centers

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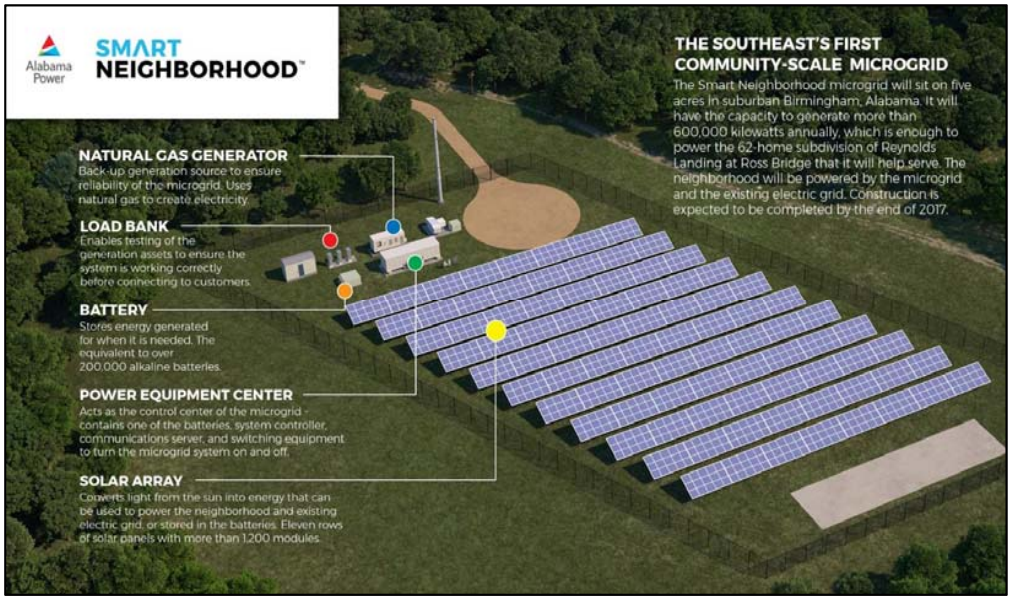
Microgrids Research – Connected Communities



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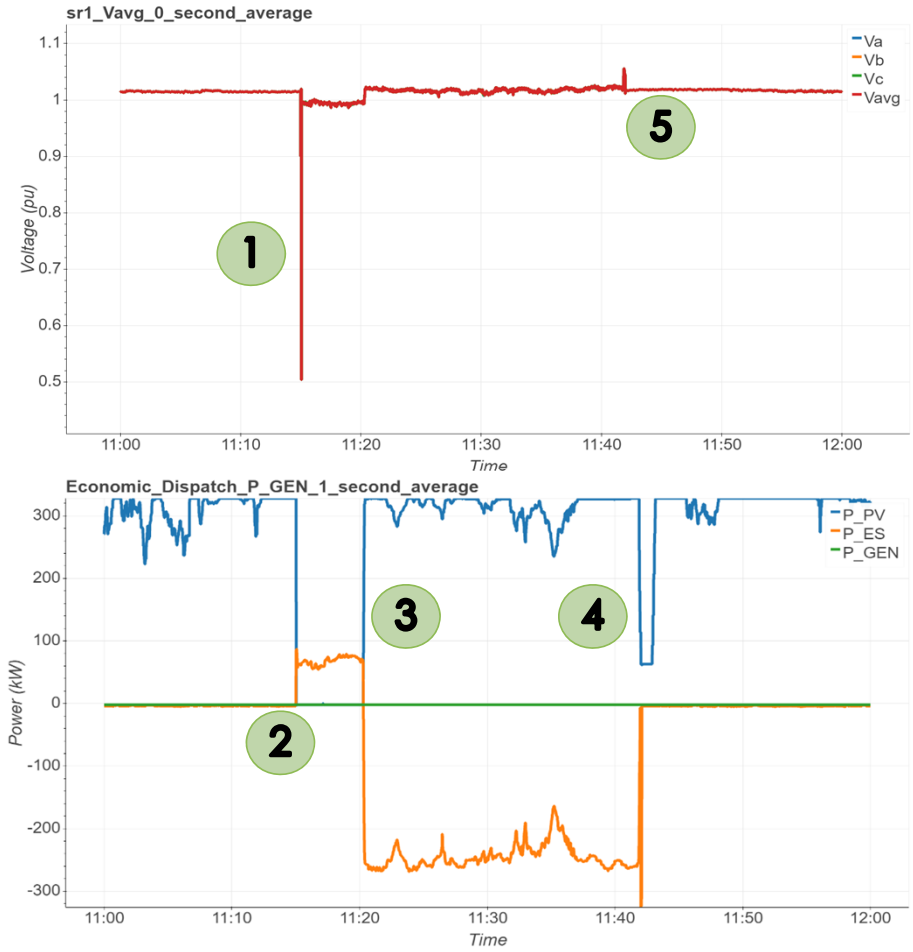
Microgrids Research



Unintentional Island

1. PCC detects voltage drop and sends flag

   PV trips offline (IEEE 1547)

2. Controller issues command to send microgrid to voltage/frequency control

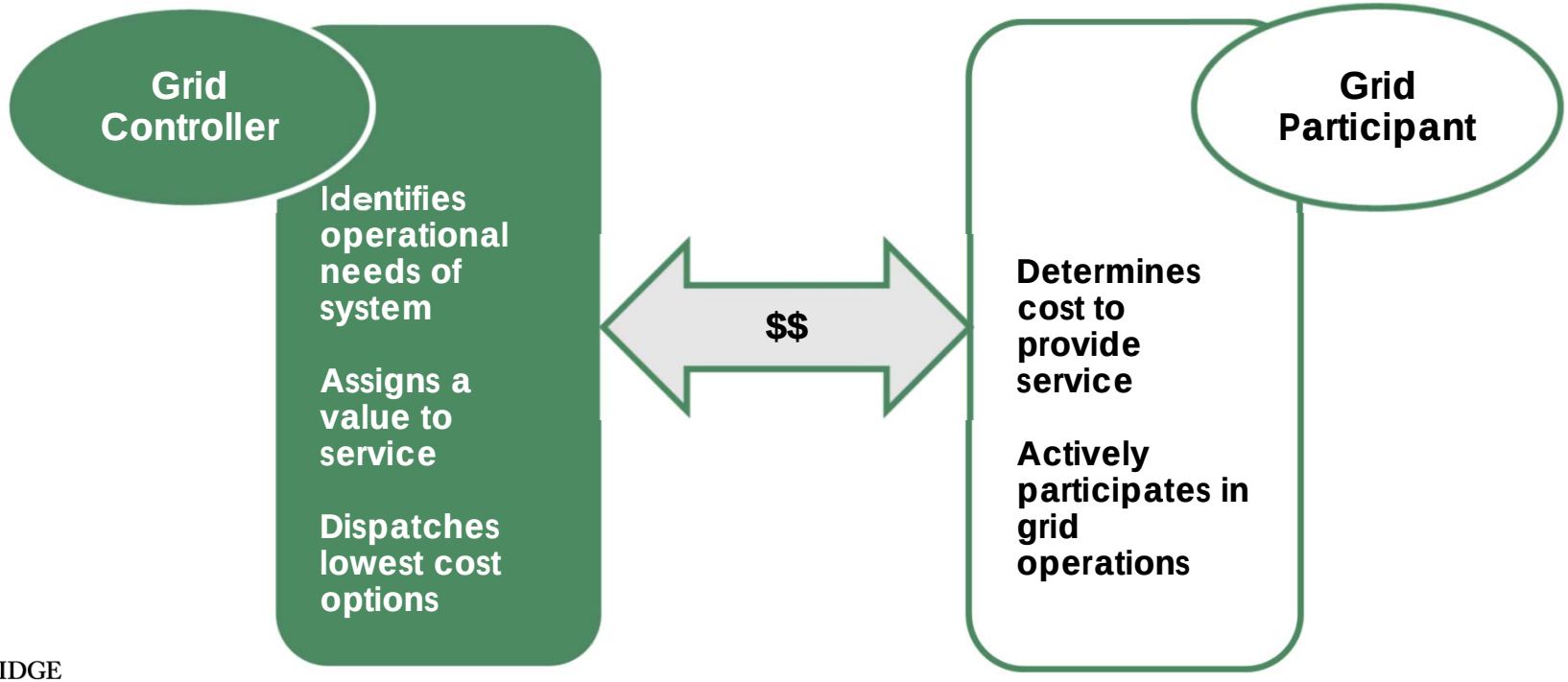
3. After 5 minutes, PV observes available grid and returns online. ES must charge.

4. After 30 minutes, controller receives the utility request to resynchronize with the main grid

5. PV is curtailed and microgrid reconnects to distribution system. Normal operation resumes

What is Transactive Energy?

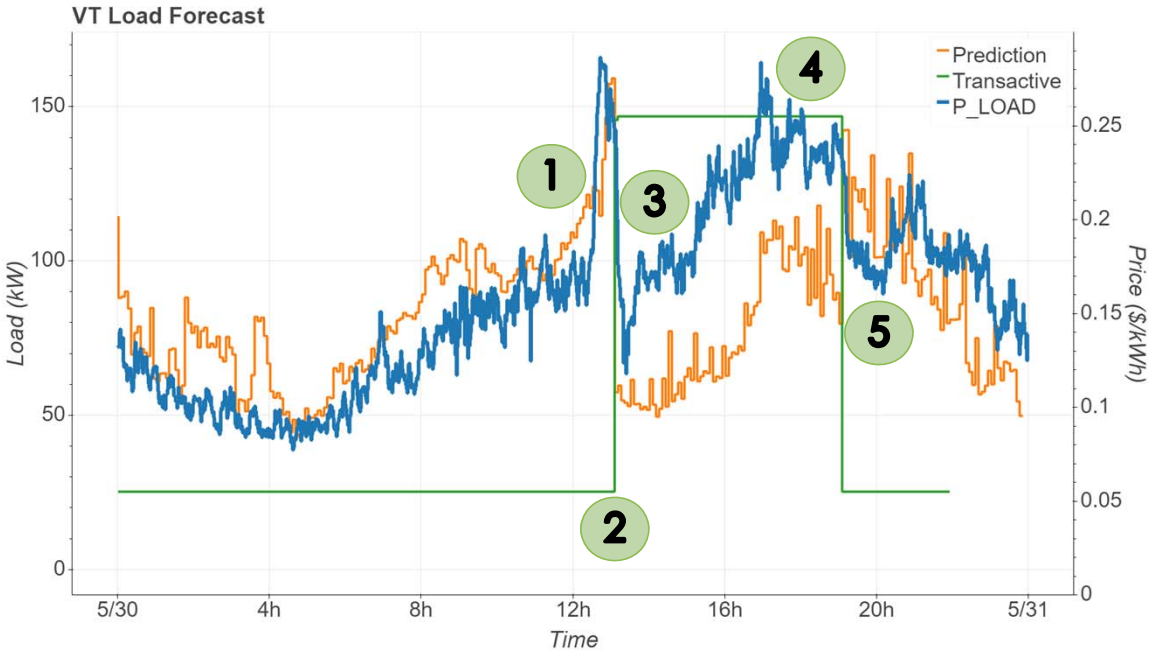
"A system of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value as a key operational parameter" - NIST



Transactive Controls for Microgrids

- Transmission price is derived from anticipated congestion
- Use the peak time from transmission price to determine when and how long peak price should be
- Issue as transactive load control signal

Transactive Controls for Microgrids

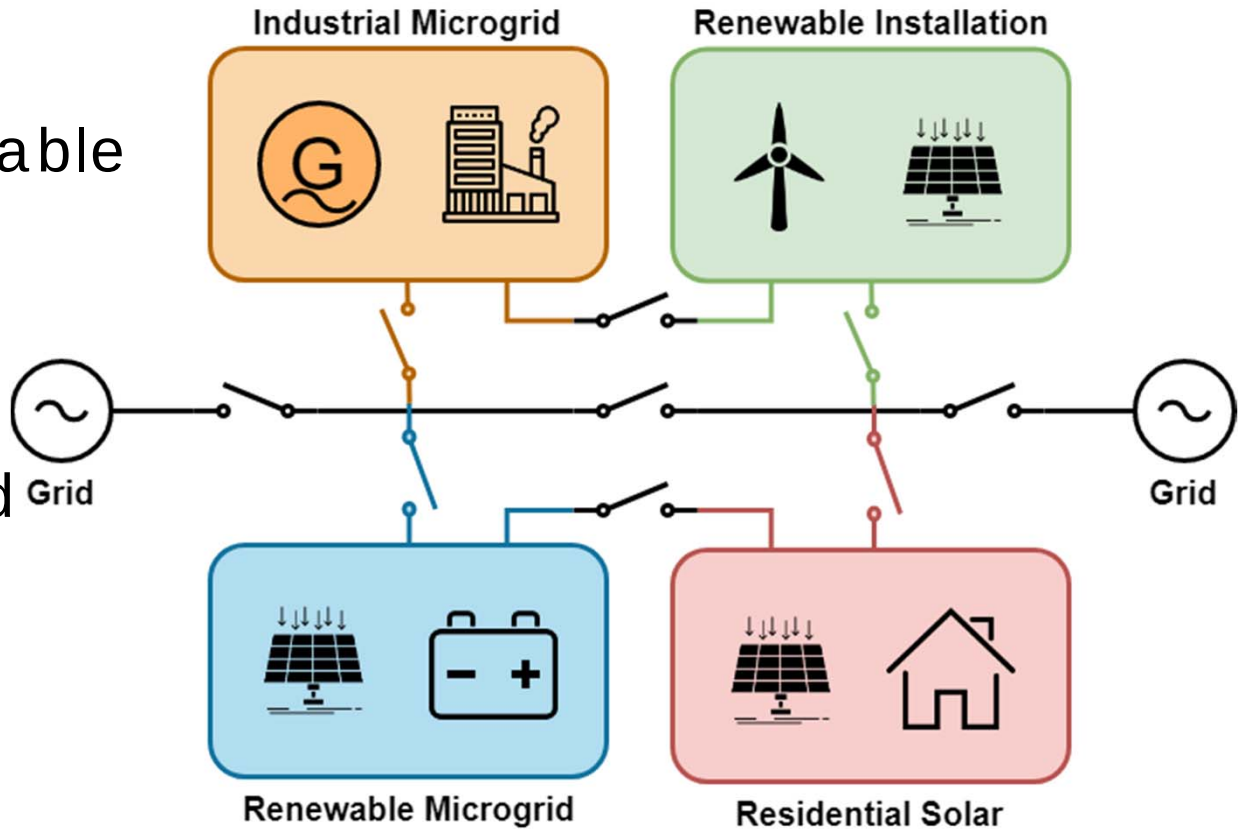


Transactive Control

1. Pre-cooling HVAC and pre-heating water heater in anticipation of peak signal
2. Peak signal begins at 1pm and continues until 7pm
3. Homes naturally heat up, but stay within comfort bands
4. HVACs begin turning back on in response to temperature exceeding comfort bands
5. Peak signal ends; return to normal operation

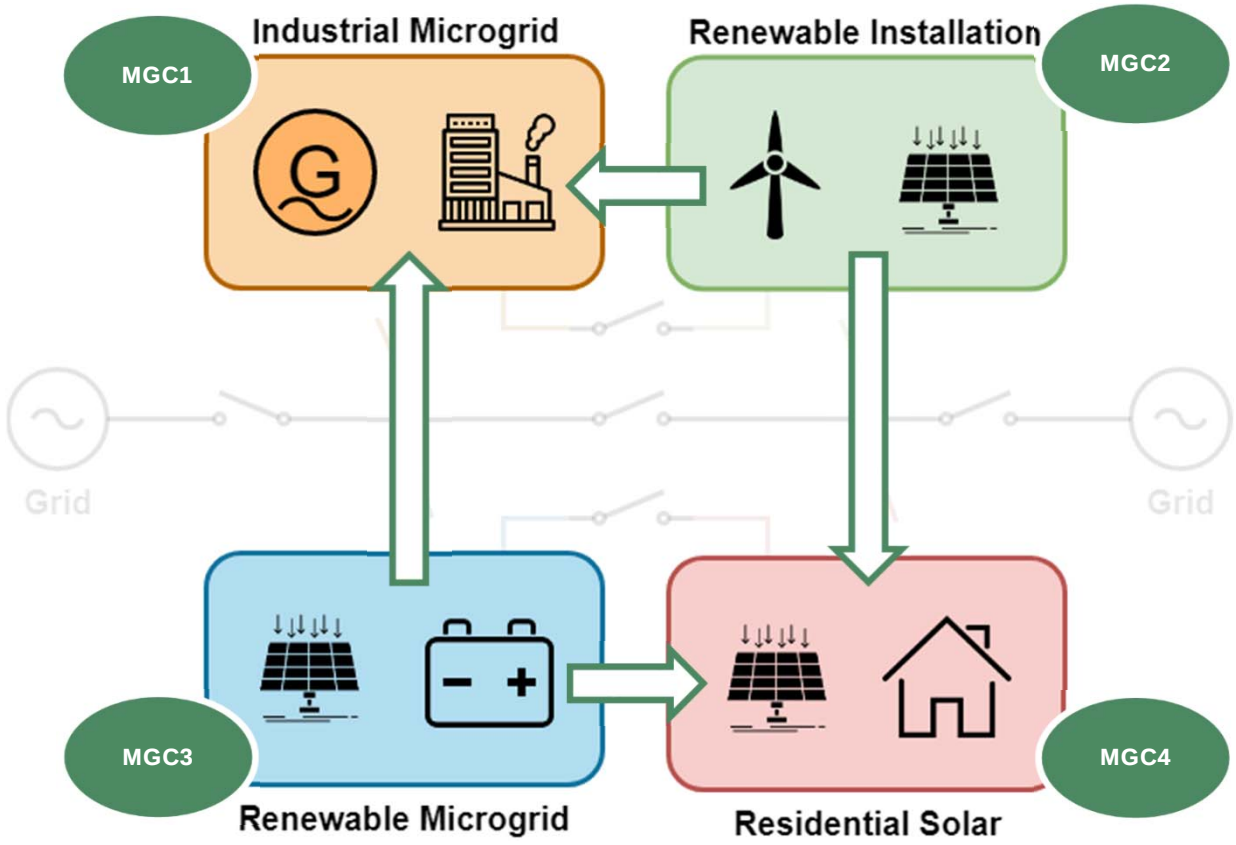
Networked Microgrids

- Series of interconnectable microgrids
- Allows for dynamic reconfiguration
- Potential for increased resiliency
- Controls and communications are difficult



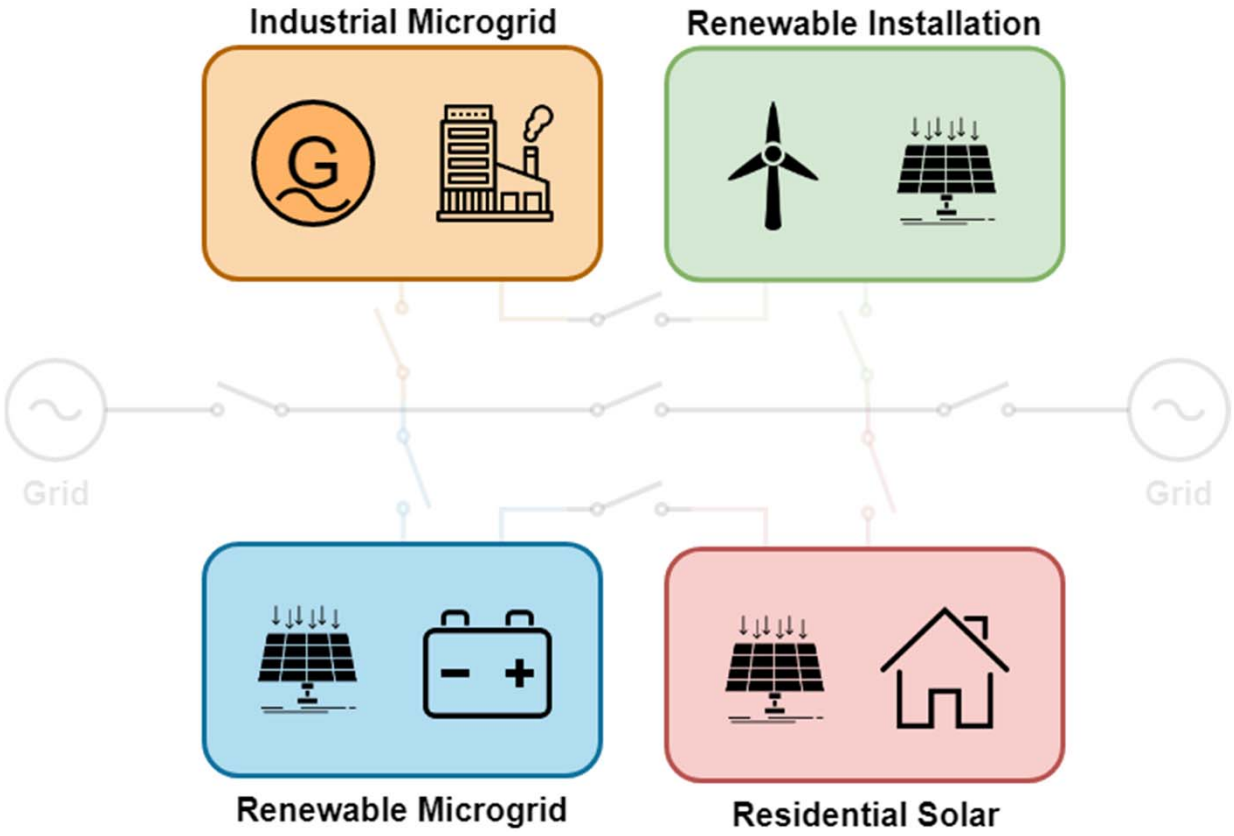
Networked Microgrids Controls – Area Flows

- Microgrids act as individual entities
- Import/export based on forecasted load and generation
- Transactive energy capable



Networked Microgrids Controls – Autonomy

- Each device has knowledge of itself and its surroundings
- The configuration state is determined and used to set a policy
- Each device operates under its own policy without sacrificing stability
- Does not require separate MGCs



Thank You